Davis Joki   Final Project
Level 1   07/28/03

Gravity Influence on Flight Paths

This activity models the height of a projectile with the TI-83+ graphing calculator. The topics covered are gravity, acceleration due to gravity, rate of change, and height in a real world situation that students might one day have to solve. This presentation would fit into the physics or math curriculum best, but it could be used to teach students how to interpret graphs from the calculator in a different course that isn't worried about the equations behind it.

This activity will require the use of a TI graphing calculator (any model should work well enough). This activity will use the graphing calculator to show the students the height of a given projectile. They will be able to change the gravity, initial velocity, and height that it is projected from to change the flight path. This activity will be done in feet, so the acceleration due to gravity is -32 feet per second per second.

First, we will define the equation for height of a projectile when in flight. This equation is: $\frac{1}{2} *$ Gravity * Time^2 + (Initial Velocity) * Time + (Initial Height). We will define gravity, initial velocity, and initial height as variables in the calculator. All students should go to their home screens and store this information in variables in the calculator. For example, gravity would be stored as –32, and can be stored in the variable called G, initial velocity can be stored in v, and initial height can be stored in h (see screen capture 1). Next, we can enter the equation into the equation editor. The equation is seen in screen capture 2.

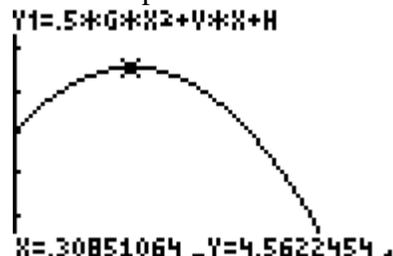Screen Capture 1   Screen Capture 2

Then, we can use the window settings to get the graph available to view and collect data from as seen in screen capture 3. Finally, we can see the flight path in the graph as seen in screen capture 4. Students may have different graphs, so they will have different windows to set also.

Screen Capture 3   Screen Capture 4

      Next, the students will trace the graph to see the maximum height that it reaches and how long it takes for the object to start on its way down as shown also in screen capture 4. This can also be found by going into the table and manually looking for it as shown in screen capture 5. Also, the students can use the built in maximum function on the graph to find the maximum height and at what time it occurs as shown in screen capture 6. For this particular example with gravity set at –32 ft/sec^2 and initial velocity as 10 feet/sec and initial height as 3, we see that the maximum height that this projectile reached was 4.56 feet high and occurred approximately .31 seconds after it was launched.

Screen Capture 5   Screen Capture 6
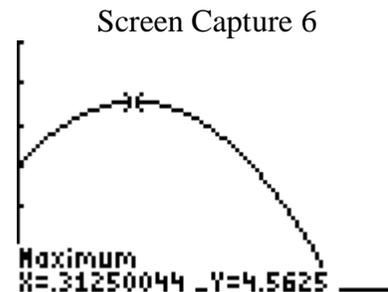
      Now that the students are familiar with the graphing capabilities of the calculator and have 3 different ways of finding maximum heights and times at which they occurred, we can move on to the analysis of what is actually going on. This next part of the project would be to change the values that are defined by the variables we set up. The students can change the gravity, the initial velocity, and the initial height to see which variables will change when and where the peak of flight is reached.

Questions:

1. Given gravity to be –32 feet per second per second, and the initial velocity of 10 feet per second, and initial height of 0 feet up from the ground, how long does it take for the projectile to reach its maximum height, and how high is it?
2. If you cut gravity in half (-16 ft/sec/sec), how high does the projectile go now? How long does it take for the projectile to reach its maximum height? What are the relationships for maximum height and maximum time with gravity?
3. With gravity at –32 and initial height remaining at 0 feet, increase the initial vertical velocity from 10 to 20 feet per second and observe the relationship of maximum height and maximum time to velocity.
4. With gravity at –32 and initial velocity at 10 feet/second, change the initial height from 0 to 100. Observe the relationship in the maximum height and time it takes to reach that height.

Acceptable Answers

1. 1.56 feet high at .3125 seconds
2. 3.125 feet high at .625 seconds
   - If you decrease gravity by ½, then you double time and height is about 1.5 times greater
3. 6.25 feet high at .625 seconds
   - If you double velocity then you quadruple height and double time
4. 101.56 feet high at .3125 seconds
   - If you increase height, the maximum height is increased by how high you raise the object in the air (they are added together). Time does not change.

Assessment:

Total assignment out of 20 points
    Point assignments:
        Q1 – 2 points
            One point for each question
        Q2 through Q4 18 points
            6 points for each of the 3 questions
                2 points for each of the data numbers
                    1 point each
                4 points for the properties
                    2 points for each property